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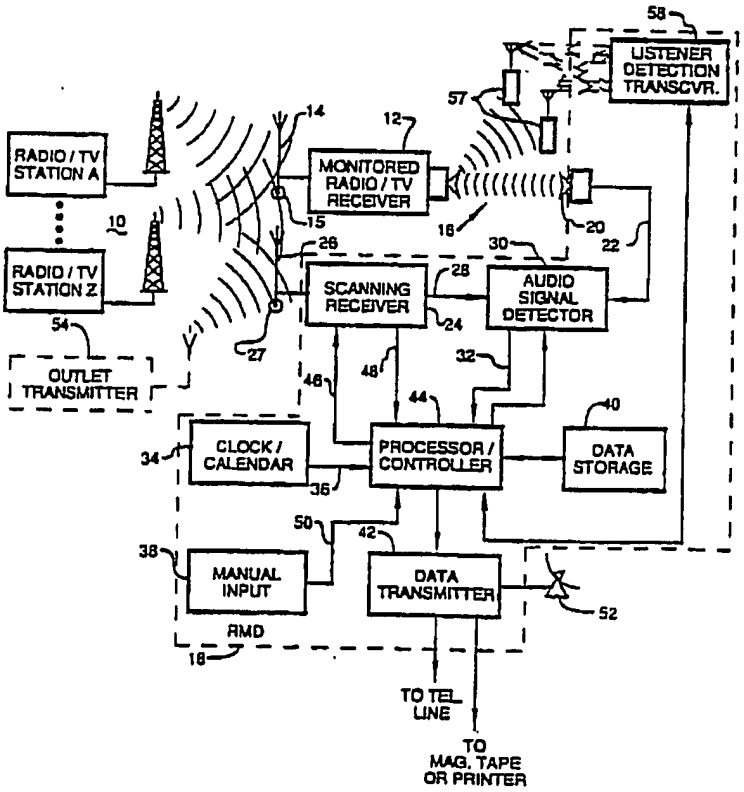
(54) Title: METHOD AND APPARATUS FOR BROADCAST MEDIA AUDIENCE MEASUREMENT

(57) Abstract

A method and apparatus for broadcast media audience measurement including a receiver (24) for scanning and sampling each broadcast frequency within a predetermined band and outputting sampled audio frequency signals, a microphone (20) for "listening" to sound emanating from a monitored broadcast receiver (12), an audio frequency signal detector (30) for comparing the scanned audio signals to the audio output developed by the microphone and for indicating a match, a clock/calendar (34) for generating time and date signals, a processor/controller (44) for causing the receiver to perform a frequency scan and for recording in a storage means (40) information including the identity of the matching station and the date and time of the match, and for causing the stored information to be transmitted to a remote location via suitable communication media. Additionally, mobile systems may also include proximity detection capability for identifying listener visits.



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Specification

METHOD AND APPARATUS FOR BROADCAST MEDIA AUDIENCE MEASUREMENT

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates generally to broadcast media audience measurement and more particularly to an improved method and apparatus for passively monitoring the listening habits of a user of an AM/FM or television receiver without requiring any physical interaction or interconnection between the monitored device or the listener/viewer.

Discussion of the Prior Art

There is an established need for methods and apparatus for enabling broadcasters and advertisers to measure the number of persons viewing or listening to each television or radio station in a given geographical area or demographic group as well as the particular programs to which they listen or view. Broadcasters need such information in order to establish advertising rates, while advertisers need the information to decide the stations and times during which they should broadcast their advertising to best reach particular demographic groups.

Prior art receiver monitors heretofore could only test individual AM or FM radio receivers, or television receivers,

but not both. Some systems require the transmission of a coded signal from a broadcast station's transmitter and detection of the coded signal at the receiver unit to determine when the particular receiver is tuned to the given station. Other systems require direct electrical or mechanical connections to the receiver unit (such as shaft encoders or position sensors on the tuner knob or station selector) to determine the station to which the receiver is tuned. Still other systems require a specially controlled test room in which listeners are under direct observation using "headsets" or other intrusive means to determine which program or station each participant selects. Other methods require the use of handwritten questionnaires, diaries or orally obtained interview responses to gather the needed data.

Examples of such methods and systems are disclosed in the United States Patents to Watanabe 3,803,349; Kemp 4,618,995; Lurie 4,626,904; Roberts et al 4,642,685; Heller, III 4,652,915; McKenna et al 4,658,290; Weinblatt 4,695,879; Kiewit et al 4,697,209; Weinblatt 4,718,106; Fulmer 4,723,302; Von Kohorn 4,745,468; Lem 4,750,034; Weinblatt 4,837,851; Gall et al 4,847,685; Welsh 4,857,999; and Lu 4,858,000. Each of the methods and systems disclosed in the above patents is subject to one or more serious shortcomings that limit their practicality, objectivity and accuracy.

Objects of the Present Invention

It is therefore an object of the present invention to provide an improved means to determine the station to which a broadcast receiver is tuned at particular points in time.

Another object of the present invention is to provide an improved means to determine the station to which a receiver is tuned at particular times without having any electrical or mechanical interconnections to the user or receiver under test.

Yet another object of the present invention is to provide an improved means to determine the station to which a broadcast receiver is tuned without having to transmit any "cue" or code signal to the receiver from a particular station's transmitter.

Still another object of the present invention is to provide an improved method for determining the broadcast station to which a TV or radio receiver is tuned at various times of the day.

A further object of the present invention is to provide an improved means to determine a station to which a broadcast receiver is tuned regardless of whether the receiver is installed in a stationary structure or a mobile facility.

An additional object of the present invention is to provide a means for determining when a vehicle having a monitored mobile receiver has "visited" a particular location.

Yet another object of the present invention is to provide a means for determining which individuals of several

are listening to a particular receiver at any particular time.

SUMMARY OF THE PRESENT INVENTION

A "Method and Apparatus for Broadcast Media Audience Measurement" including a receiver for sequentially sampling each broadcast frequency within a predetermined band and outputting sampled audio frequency signals, a microphone for "listening" to sound emanating from a monitored broadcast receiver, an audio signal detector for comparing the scanned audio signals to the audio output developed by the microphone and for indicating a match therebetween, a clock/calendar for generating time and date signals, a processor/controller for causing the receiver to perform a frequency scan and for responding to the detected match signal to record in a data storage means the identity of the matching station (or frequency) and the date and time of the match, and for causing the stored information to be periodically transmitted to a remote location via telephone line or other suitable electronic communication media or to be stored in other memory means or in hard copy using magnetic storage media or a printer. The system may also include a keyboard for manual input to accommodate preference polling, merchandise purchase data entry or other user interaction. Additionally, mobile systems may also include proximity detection capability for identifying listener visits to particular advertiser facilities or the like. Similarly, means may be provided for determining which of several possible

individuals may be listening to a particular receiver at a particular time.

Among the numerous advantages of the present invention is that insofar as the listener/viewer and the monitored radio/TV receiver is concerned, the apparatus is entirely passive and requires no physical interconnection or interrelationship therewith.

Another advantage of the present invention is that it may be implemented to automatically report the results of its operation at any desired interval or on a real time basis without user interaction.

Still another advantage of the present invention is that it may be combined with special low power transmitting means to report user visitation to particular locations or facilities.

These and other objects and advantages of the present invention will no doubt become apparent to those of ordinary skill in the art after having read the following detailed description which makes reference to the several figures of the drawing.

IN THE DRAWING

Fig. 1 is a block diagram generally illustrating the principal components of the present invention together with their relationships to various broadcast transmitters and the monitored radio/TV receiver;

Fig. 2 is a block diagram illustrating one implementation of the audio signal detector included in the

apparatus depicted in Fig. 1 of the drawing; and

Fig. 3 is a block diagram illustrating how a single embodiment of the present invention can be used to monitor remotely located receivers.

BRIEF DESCRIPTION OF PREFERRED EMBODIMENT

Referring now to Fig. 1 of the drawing, a plurality of radio/TV stations and their broadcast transmitters are indicated at 10, and a monitored radio/TV receiver and its receiving antenna are depicted at 12 and 14 respectively. The sonic output of receiver 12 is suggested by the waves 16.

Shown within the dashed lines 18 is a Receiver Monitoring Device which will hereinafter be referred to as RMD 18. As indicated, RMD 18 includes a microphone 20 for picking up sound emanating from the receiver 12 and developing an audio signal on line 22, and a frequency/channel/station scanning receiver 24 and associated antenna 26 for detecting RF signals generated by the various stations 10 and for developing audio outputs on line 28 corresponding to the voice and/or music signals broadcast to the public. As used herein, the terms broadcast signal and broadcast frequency refer to information-carrying signals of any type transmitted over any suitable transmission medium. Note that as alternatives to the antennas 14 and 26, coaxial connection from a satellite receiving dish or cable system may be made at "Tee" connections 15 and 27.

The system also includes an audio signal detector 30 for comparing the audio signals input on lines 22 and 28 and for developing a "match" signal on line 32 when the audio output of receiver 24 matches the audio output of receiver 12. This is to say that as scanning receiver 24 is stopped from one broadcast frequency to another, if the audio portion of the broadcast signal matches the audio output of the monitored receiver 12, a signal indicating the detection of the match will be generated on line 32.

RMD 18 further includes a clock/calendar 34 for outputting date and time signals on line 36, a manual input pad or keyboard 38, a data storage means 40 typically comprising ROM and RAM memory devices, and a data transmitter 42. The heart of RMD 18 is an electronic processor/controller 44 which is preprogrammed to control the overall operation of the device. One important function is that it generates signals on line 46 for causing scanning receiver 24 to either sequentially scan a particular spectrum of broadcast frequencies or to scan preselected discrete frequencies in a particular order or to scan preselected discrete frequencies at preselected times. Controller 44 also receives the match signal on line 32 and in response thereto causes a station identifier signal fed back on line 48 and the date and time signal input on line 36 to be stored in data storage means 40. The duration of time each station is being viewed or listened to can be obtained from data accumulated from repeated scans across the scanned frequency band. Likewise, the times and periods during which no

station is listened to can be obtained in the same way.

In addition, controller 44 may also cause a manual input signal developed on line 50 to likewise be stored in data storage means 40. Such manual input might be as basic as a simple yes or no preference polling, or could involve the input of opinion statements, merchandise purchase entries, etc. It will be understood that either new sampled data or analyzed and processed data can be stored in data storage means 40 and/or transmitted via transmitter 42.

Controller 44 can also be programmed to cause information (including unit and/or location information) stored in memory means 40 to be read out to the data transmitter 42 for transmission via a radio wave or microwave facility 52 to a remote data gathering center. Alternatively, the data can be transmitted to the center or any other specified terminal via a modem-linked telephone line, or can be fed to a magnetic tape or disk drive, or printer to produce a "hard copy" which can be physically delivered to the center. As will be further explained below, RMD 18 also has the capability of indicating when the person or vehicle carrying the RMD is in the vicinity of a particular retail outlet or other location having an identifying outlet transmitter 54.

Another capability of the present invention is its ability to not only identify the station to which a particular receiver is tuned but also to determine which of several identifiable listeners are present in the vicinity of the monitored receiver. This may be accomplished as

indicated in Fig. 1 by requiring that the listeners have attached to their person, or carry in one way or another, a small transponder device such as that depicted at 57. Such devices respond to an RF, sonic or optical signal generated by a listener detecting transceiver 58 forming a part of RMD 18 and return a signal which may be used to identify the party associated with the responding device. For example, each individual within a monitored household might be given a transponder or "beeper" 57 that emits a characteristic signal in response to receipt of a beeper "command signal" transmitted from transceiver 58 to all beepers simultaneously by way of RF transmission (like a remote-controlled garage door opener). One way in which each beeper could be identified would be to have each beeper emit a selected characteristic (audio range or "ultrasonic") signal with a delay unique to each beeper following receipt of the beeper "command signal." Such return signals would then be detected by transceiver 58 which in turn would relay such information to data storage unit 40 under control of processor/controller 44. The beeper command signals could be programmed to be transmitted, for example, at quarter-hour intervals to query which individual(s) are listening to a given receiver. The RMD 18 would then store in its memory information as to which beepers (i.e., individuals) the audience measurement data corresponds.

In use, the RMD is placed in physical proximity, i.e., in the same house, same room or same vehicle as the primary monitored unit 12 and is powered either from a self-contained

battery or from a local available source of power from the building or vehicle in which it is placed. The RMD has a serial number recorded within its data storage means 40 to allow identification of the unit and to allow correlation of its data with its intended user/location. The RMD determines the station to which the monitored unit 12 is tuned by "listening" to the sound emanating from the units speaker, and while listening, automatically determines the broadcast station frequency or channel to which the receiver is tuned.

As will be understood from the above, the illustrated preferred embodiment has the capability of determining the station to which a radio or television set is tuned without the use of any electrical or mechanical connection to the monitored receiver. Its only limitations are that it or a connected microphone be within "hearing" distance of the receiver and that its receiving antenna not be blocked in any way that would materially interfere with its receipt of the broadcast signals of interest. However, this is not to say that as a matter of convenience one could not substitute a plug for the microphone where the monitored receiver is provided with an appropriate earphone jack or other suitable audio output jack. The unit is self-contained, completely passive and operates on the same principal regardless of whether an AM radio, FM radio or a television receiver is being monitored. Moreover, it has the ability to determine the station to which the monitored receiver is tuned without requiring that the received station transmitter transmit any characteristic signal.

Referring now to Fig. 2 of the drawing, the principal functional components of one embodiment of the audio signal detector 30 are depicted. These elements includes a phase delay circuit 60 for delaying the audio signal input on line 28 so that it is time coincident with a corresponding audio signal input on line 22. The delay compensated for would normally be primarily that attributable to the time lost as a result of sound traveling the distance between monitored receiver 12 and microphone 20. Delay means 60 may be preset at a fixed value or may be of a type which dithers the phase on either side of a selected phase delay so as to automatically accommodate different distances between receiver and microphone. As indicated, the delayed signal may be squared in a squaring circuit 62 to facilitate its comparison and communicated via a line 64 to one input of a signal comparator 66. Comparator 60 might, for example be comprised of a synchronous detector, a lock-in amplifier, a phase detector, a difference amplifier, a signal correlator or correlation detector, etc., wherein the signal on line 64 serves as the reference input to which the audio signal input on line 72 would be compared. The use of a synchronous detection means is preferable in that it has the ability to better exclude the unwanted effects of background noise in the audio input signal.

The audio input from microphone 20 on line 22 is first applied to an automatic gain control circuit (AGC) 68 which adjusts the gain of the signal to an acceptable level before it is input via a switch 70 into a second input 72 of

comparator 66. If comparator 66 finds a match between the signals input on lines 64 and 72, it will develop an output on line 74 which is then "sampled and held" by a sample and hold circuit 76 and made ready for output on line 36a for input to processor 44.

It may be desirable to know the stations to which each of several receivers within a given household are tuned. This can be accomplished as indicated in Fig. 3. The several household receivers, including a primary or "local" receiver 90 and a plurality of remote receivers 92, can be monitored by as few as one RMD 94 placed in some centralized location. The RMD 90 listens to the receivers in a given household via remote microphones 94 installed into each room in which a receiver could be placed. Such microphones transmit their received audio signals to RMD 94 through any suitable signal connecting means 98 such as, for example, an intercom connected to and powered by the household AC wiring. The output of each remote microphone is then multiplexed into the RMD using a suitable multiplexing means 100, the multiplex "switch" position being indicative of which room the corresponding microphone 96 is placed.

The above described elements constitute the basic circuit components used to detect the frequency (radio station or TV aural channel) at which the monitored receiver 12 (Fig. 1) is currently set. However, as previously indicated, in the case of units monitoring a receiver carried in a mobile unit such as an automobile, truck or camper, it may be desirable to determine when the mobile unit has

"visited" or at least been in the immediate vicinity of a particular commercial outlet or other facility, such as a fast food restaurant, auto dealership or other advertising establishment or location. This can be accomplished using the present invention by providing at each outlet to be identified, a low power RF transmitter which broadcasts at a predetermined frequency, with each outlet having a dedicated tone modulated onto its carrier. This tone can either be a particularly selected single frequency tone either continuously broadcast or pulsed in some specific manner, or can be a selected pattern of different tones uniquely identifying the particular outlet.

It will be appreciated that when the mobile unit is within signal range of the outlet, scanning receiver 24 will detect the carrier frequency as it is stepped across the band including that carrier frequency under control of processor/controller 44, and in a manner similar to the processing of a broadcast signal will demodulate the detected signal and cause the identifying audio tone to be generated on line 28 (Fig. 1). In order to detect and identify this tone, several alternative methods can be used. As one example, the detector 30 might be provided with a selectable tone generator 80 which, under control of processor 44 via line 82, will sequentially generate a sequence of tone signals including that assigned to the outlet 54, and will output such signals on line 84 for input to the second input 72 of comparator 66 via switch 70.

At the same time that tone generator 80 is activated by a signal developed by controller 44 on line 82, switch 70 would be switched in response to a signal developed on a control line 86 by controller 44, from its first position connecting the signal from microphone 20 into comparator 66 to a second position connecting tone generator 80 to input 72. As in the previously explained case where the compared audio signal was from microphone 20, comparator 66 would in this instance compare the outlet transmitter signal input on line 64 to the tone generator signal developed on line 84 and coupled into line 72, and when parity is found would generate an identifying output on line 74 for input through sample and hold circuit 76 and line 32a to data storage 40 (Fig. 1) under control of controller 44.

As another example, the tone generator 80 would not be used and controller 44 would be programmed to not look for a match signal and on line 32a and would instead look only to see if an output was present on line 32c. During the intervals within which receiver 24 is tuned to an outlet transmitter frequency, the presence of an output from signal level detector 92 would merely indicate that a signal was received from a particular outlet transmitter and from such information, it could be inferred that the RMD was within the range of reception of the particular outlet transmitter. The occurrence of this "event" would then cause that locations identity together with the associated date and time information to be stored in memory unit 40 for subsequent retrieval and possible correlation with previously broadcast

advertising if, or when, desired.

It will be appreciated that such outlet proximity identifying information when combined with the date and time information will provide useful information when correlated with the monitored receiver listening information. For example, it might be of interest to note that within a particular period of time following the broadcast and detected listening to of a particular advertisement on receiver 12, the mobile unit carrying unit 12 appeared at an outlet identified in the advertisement.

In addition to the above-mentioned features, audio detector 30 may also have the ability to determine those times during which the listener is not listening to broadcast signals but is instead listening to other music or other tape recorded matter. In accordance with the present invention, such information can be obtained by amplifying the audio input detected by microphone 20 using a gain stage 88 together with either a low pass or high pass filter 90 which blocks normal oral conversation frequencies and passes only signals likely to come from recorded music for example. It will be appreciated that the presence of a signal appearing on line 32b in the presence of a signal appearing at the output of squaring circuit 62, as detected by a suitable signal level detector 92 and communicated to controller 44 via line 32c, but with no match found after several sampling sweeps, will indicate that even though no match was detected there was in fact music or other non-verbal sound being generated in the vicinity of microphone 20. Furthermore,

where no appropriate sound is detected in the vicinity of microphone 20, these same device components could be used to indicate to controller 44 that the device should be placed in a "standby mode" and controller 44 could, in response, actuate appropriate powerdown circuits to conserve energy until sounds of interest are again present.

A battery powered RMD can also be used to monitor portable receivers. For example, an RMD can "listen" to radios/TVs at a particular gathering of people such as at a beach if someone carries the unit around on their persons and can thereby determine the number distribution of stations being listened/tuned to by the persons in attendance.

Although the present invention has been described above in terms of a particular preferred embodiment, it is to be understood that additional features, alternatives and modifications of the described embodiment will be apparent to those skilled in the art after having read this disclosure. It is therefore intended that the scope of the appended claims not be limited by such disclosure but that such claims be interpreted broadly to cover all such matter as falls within the true spirit and scope of the invention.

What is claimed is:

IN THE CLAIMS

1. Broadcast media audience measurement apparatus for placement within sonic communication range of at least one monitored broadcast receiver comprising:

broadcast signal receiving means scannable over a predetermined frequency band including identifiable broadcast carrier frequencies and operable to briefly tune to and develop a first signal corresponding to the audio information contained within each selected broadcast frequency;

microphone means responsive to sonic energy input thereto from said monitored broadcast receiver and operative to generate a corresponding second signal;

detector means for comparing said first and second signals and for developing a match signal when said first signal is equivalent to said second signal;

clock/calendar means for generating date and time signals corresponding to each said match signal;

data storage means; and

processor/controller means for causing said broadcast signal receiving means to step from one identifiable broadcast frequency to another within said predetermined frequency band, and in response to said match signal being operative to cause information including a broadcast frequency identifying signal and corresponding date and time signals to be stored in said data storage means.

2. Broadcast media audience measurement apparatus as recited in claim 1 and further comprising data communication means under control of said processor/controller means and operative to output information stored in said data storage means.

3. Broadcast media audience measurement apparatus as recited in claim 2 wherein said data communication means includes means for coupling such information into a telephone line.

4. Broadcast media audience measurement apparatus as recited in claim 2 wherein said data communication means includes means for coupling said information to an external data storage means.

5. Broadcast media audience measurement apparatus as recited in claim 2 wherein said data communication means includes means for communicating said information to an electro-magnetic wave transmission medium.

6. Broadcast media audience measurement apparatus as recited in claim 1 wherein said signal detector means includes signal delay means for time delaying said first signal sufficient to bring it in to time coincidence with a corresponding second signal.

7. Broadcast media audience measurement apparatus as recited in claim 1 and further comprising selectable tone generator means for generating a third signal having predetermined characteristics identifying a particular carrier frequency within said band, and means under control of said processor/controller means for coupling said third signal to said detector means in place of said second signal whereby the detection of a particular source of carrier frequency identified by said third signal can be signified independent of any sonic input into said apparatus.

8. Broadcast media audience measurement apparatus as recited in claim 7 whereby means are provided for inferring from the said identification that said apparatus is within a determinable proximity of said source when it is known that the identified source has a limited broadcast range.

9. Broadcast media audience measurement apparatus as recited in claim 1 and further including signal level detector means responsive to said first signal and operative to generate a signal indicating to said processor/controller means that a signal from a particular broadcasting source known to be the sole broadcaster at the selected frequency has been detected, whereby if the source has a limited broadcast range, detection of such signal indicates that said apparatus is within a determinable proximity of said source.

10. Broadcast media audience measurement apparatus as recited in claim 1 and further comprising transceiver means operating under control of said processor/controller means for generating a signal in the vicinity of a monitored broadcast receiver which will activate audience member carried transponding means which in turn will return member identifying signals for detection by said transceiver means.

11. Broadcast media audience measurement apparatus as recited in claim 10 wherein said transceiver means generates a command signal for simultaneously actuating all said transponding means within a predetermined range thereof and subsequently identifies the source of each returned member identifying signal as a function of some predetermined characteristic thereof.

12. Broadcast media audience measurement apparatus as recited in claim 11 wherein each said transponding means is caused to generate a return signal at a different predetermined time following receipt of said command signal, and wherein said transceiver means identifies the source of a particular return signal as a function of its time of detection.

13. Broadcast media audience measurement apparatus as recited in claims 1, 10, 11 or 12 wherein said microphone means including a plurality of remotely located microphones and a multiplexing means for sequentially inputting second

signals from each said microphone into said detector means for comparison to each said first signal.

14. A method of measuring broadcast media audience participation comprising the steps of:

detecting sonic energy developed by at least one particular broadcast receiver and generating a corresponding first signal;

detecting in sequence a plurality of broadcast signals within the range of receipt by said receiver and generating a second signal corresponding to each broadcast signal detected;

comparing each said second signal to said first signal and generating broadcast signal identifying information and date and time information corresponding to each occurrence of a match between said first signal and said second signal.

15. A method as recited in claim 14 and further comprising the steps of storing said information and periodically communicating the stored information to a remote user.

16. A method as recited in claim 14 and further comprising the steps of detecting the receipt of a broadcast signal broadcast from a source known to have a limited range and determining therefrom that the detecting entity was within a determinable proximity of the source at a particular date and time.

17. A method as recited in claim 14 and further comprising:

generating a command signal for actuating audience member carried transponder means;

receiving return signals generated by said transponder means; and

using the received returned signals to signify the presence of particular members in the vicinity of said particular broadcast receiver.

18. A method of measuring broadcast media audience participation comprising the steps of:

detecting the audio output developed by at least one particular broadcast receiver and generating a corresponding first signal;

detecting in sequence a plurality of broadcast signals received by said receiver and generating a second signal corresponding to each broadcast signal detected; and

comparing each said second signal to said first signal and generating broadcast signal identifying information and date and time information corresponding to each occurrence of a match between said first signal and said second signal.

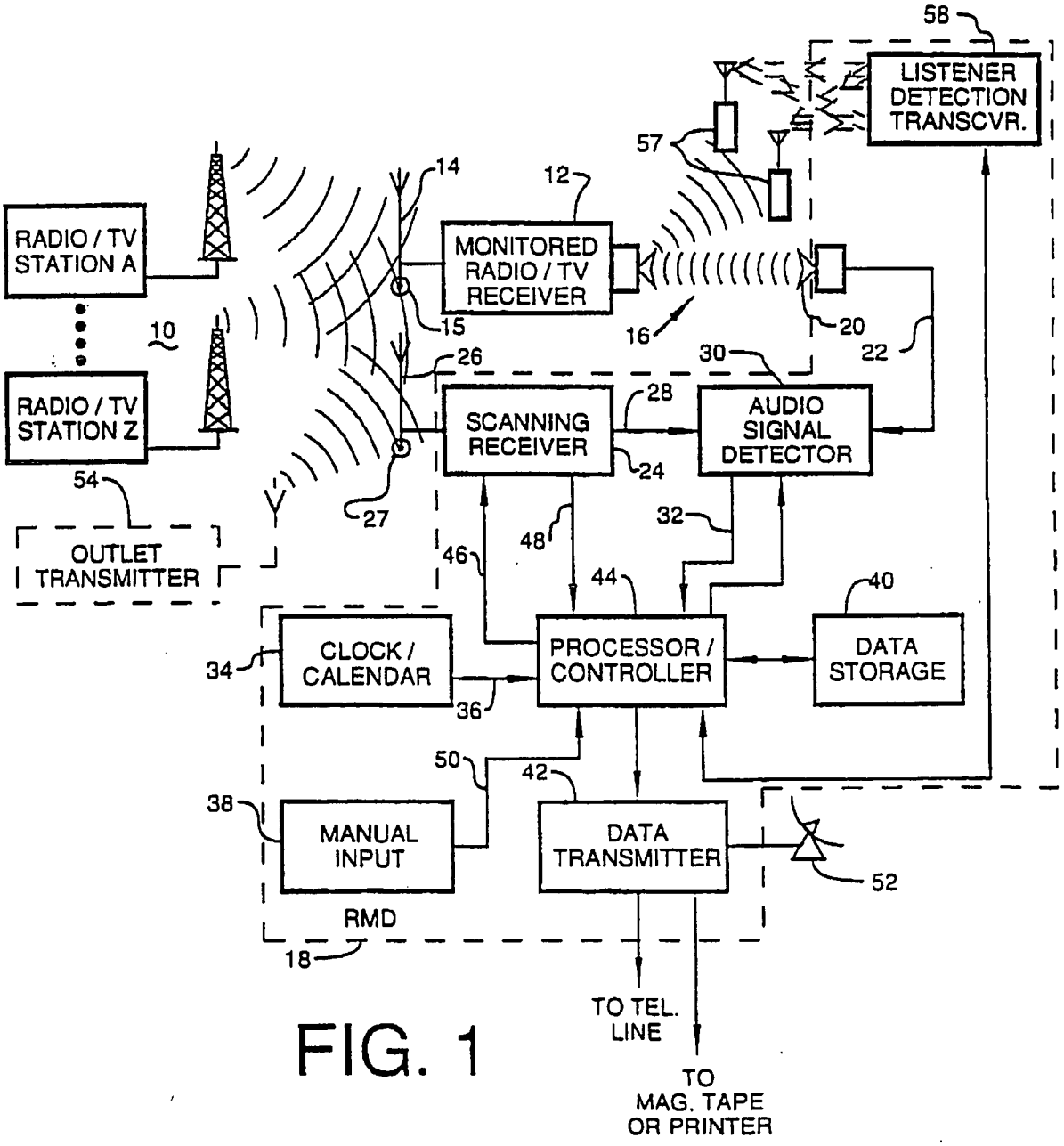
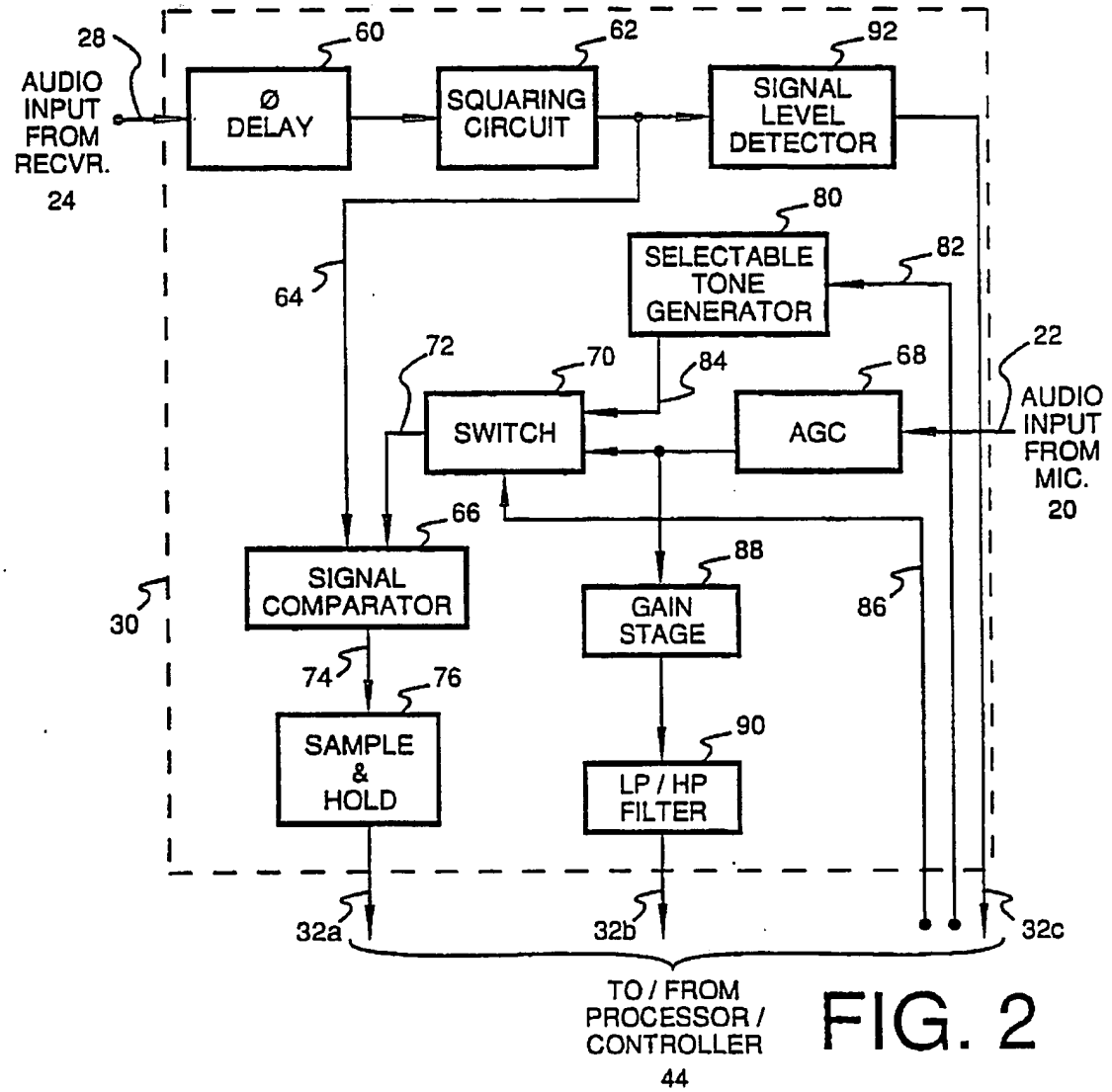

RADIO / TV STATION A
RADIO / TV STATION Z
10
54
OUTLET TRANSMITTER
14
15
12
MONITORED RADIO / TV RECEIVER
16
57
58
LISTENER DETECTION TRANSCVR.
20
22
30
26
27
SCANNING RECEIVER
28
24
AUDIO SIGNAL DETECTOR
32
48
46
44
40
34
CLOCK / CALENDAR
36
PROCESSOR / CONTROLLER
DATA STORAGE
50
42
38
MANUAL INPUT
DATA TRANSMITTER
52
RMD
18
TO TEL. LINE
TO MAG. TAPE OR PRINTER

FIG. 1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AUDIO INPUT FROM RECVR. 24
60
Ø DELAY
62
SQUARING CIRCUIT
92
SIGNAL LEVEL DETECTOR
80
SELECTABLE TONE GENERATOR
82
64
72
70
84
68
22
SWITCH
AGC
AUDIO INPUT FROM MIC. 20
66
88
30
SIGNAL COMPARATOR
GAIN STAGE
86
74
76
90
SAMPLE & HOLD
LP / HP FILTER
32a
32b
32c
TO / FROM PROCESSOR / CONTROLLER 44

FIG. 2

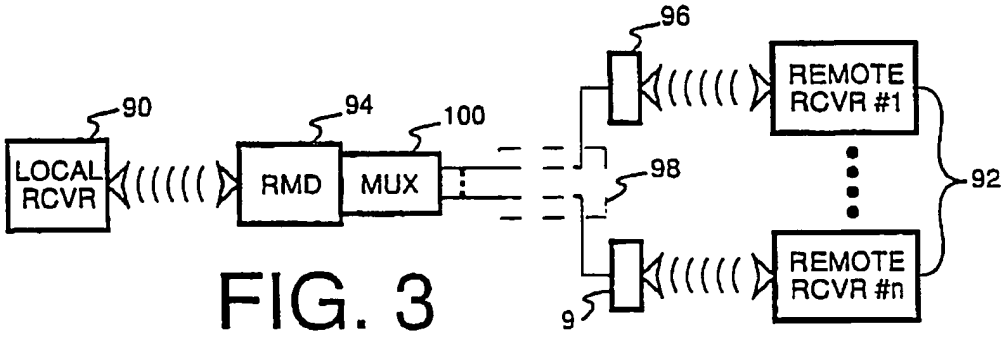
96
90
94
100
LOCAL RCVR
RMD
MUX
98
REMOTE RCVR #1
92
REMOTE RCVR #n
9

FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US91/00310

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC(5): H04B 17/00 H04H 9/00
US CL.: 455/2,67 358/84

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
US	455/2,67 358/84

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X Y	US, A, 4,955,070 (WELSH et al.) 04 September 1990 See entire document.	1-4,14-15,18 5-6 and 9-17
Y	US, A, 4,626,904 (LURIE) 02 December 1986 See column 1.	10-12 and 17
Y	US, A, 3,803,349 (WATANABE) 09 April 1974 See figure 1.	13

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search

09 MARCH 1991

Date of Mailing of this International Search Report

15 APR 1991

International Searching Authority

ISA/US

Signature of Authorized Officer

LISA CHAVONEL